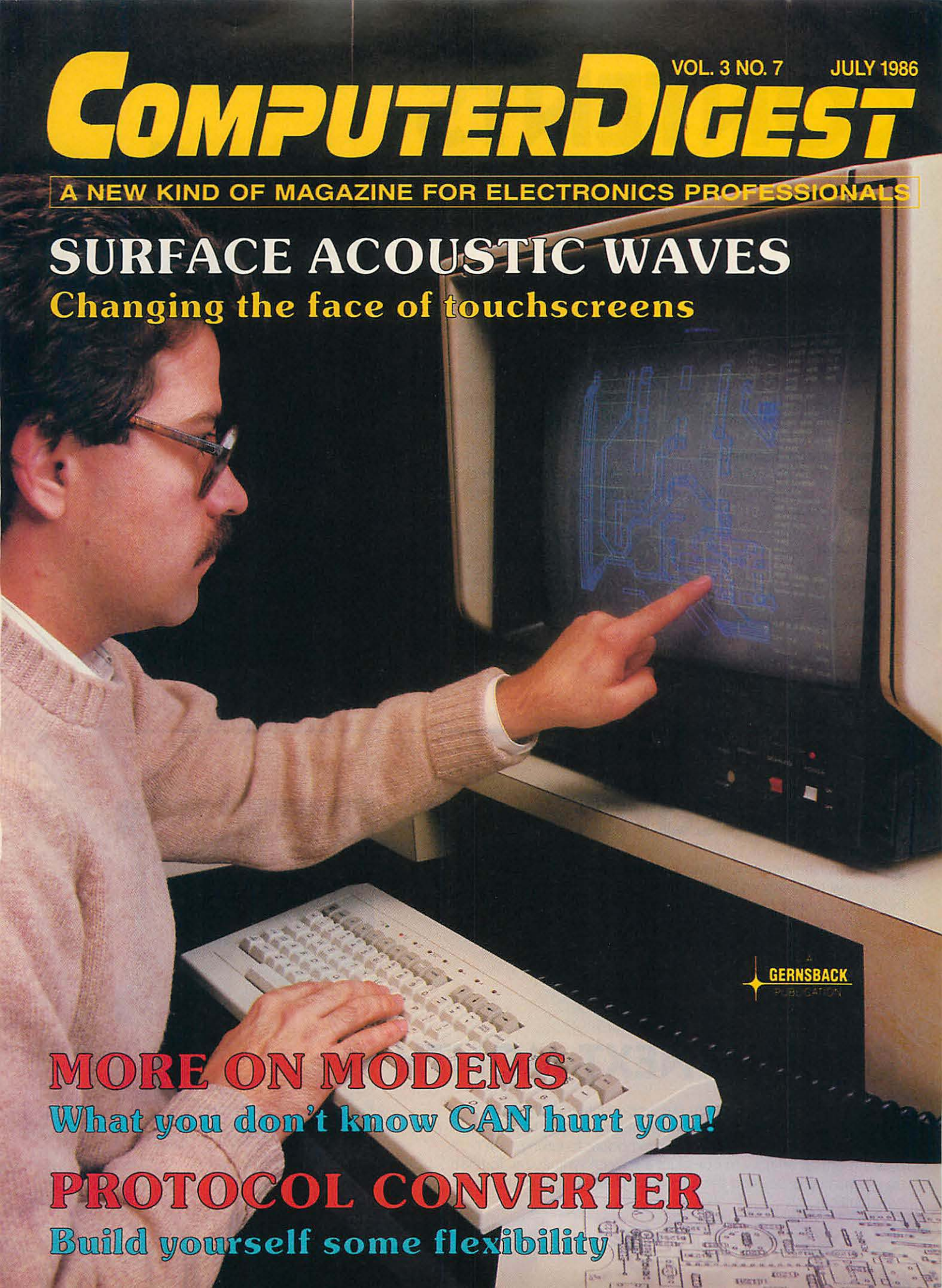
VOL. 3 NO. 7 JULY 1986

COMPUTERDIGEST

A NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

SURFACE ACOUSTIC WAVES

Changing the face of touchscreens



A GERNSBACK PUBLICATION

MORE ON MODEMS

What you don't know CAN hurt you!

PROTOCOL CONVERTER

Build yourself some flexibility

CONTENTS

Vol. 3 No. 7 July 1986

7 More On Modems
Here's all you'll need to know if you're having trouble getting your modem to "talk." **Herb Friedman**

11 Protocol Converter
Sometimes it takes a protocol converter to get things handshaking properly. You can build this one yourself. **R.L.L. Hu**

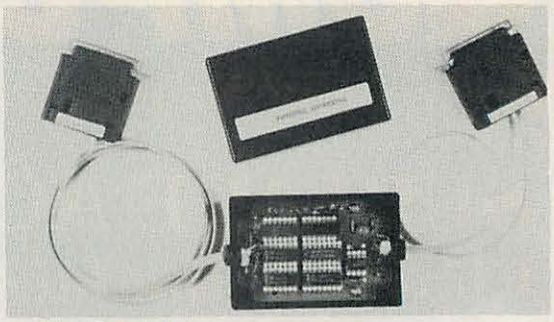
15 Touchscreen Technology
Surface Acoustic Waves are changing the face of Touchscreens. Here's an update on what to expect from this new technology. **Marc Stern**

3 Editorial

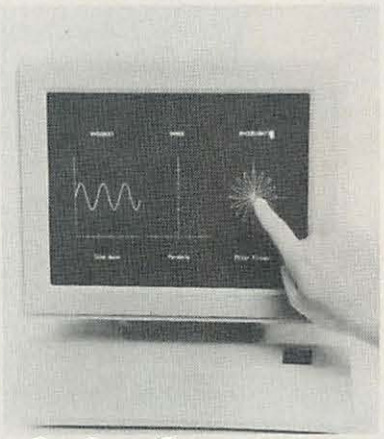
4 Letters

4 Computer Products

5 Software Review



See Page 11



See Page 15

ON THE COVER

S.A.W.—Surface Acoustic Waves provide an additional dimension to this new touchscreen from Zenith. Reflectors along the top of the screen bounce the acoustic waves being transmitted from left-to-right at the top, to detectors along the bottom. Result? Another axis-full of information! See page 15.

COMING NEXT MONTH

Making an older printer perform like a new printer is *always* worth the doing, and we have a story on Retrofitting Printers to tell you how. And if you'd like to get your Commodore to talking, don't miss this article on how to construct a speech synthesizer. To finish up a dynamite issue, read the tutorial on designing single-transistor switching circuits.

EDITORIAL

C'mon, you guys!

■Each month your editor has a series of jobs to do, and one of the toughest of them is picking the articles that will appear in print. We try to select a balance of articles that will appeal to the most interest. And we select these from the articles that are submitted by people just like you. But there are other mitigating factors that you may not know about. Because we are limited in space, smaller articles have a far-better chance. The piece that will fill two or three pages in the magazine is more apt to see the printed page than the one that runs ten or twelve pages and has to be serialized over several issues. And right now there happens to be a shortage in the files of the short articles.

Here are some guidelines: Begin by looking through this issue (and previous issues) to see what sort of thing we publish. Got an idea that seems to fit? Send me a letter and tell me about it. If we haven't just bought an identical story from somebody else, if we haven't just published one like it, You'll probably get a letter back asking you to proceed. Now you write the story, making sure it's double-space typed, with ample borders all around. Be sure your name and address are on the cover sheet. Refer to the figures *sequentially* in the text. In other words, don't talk about Fig. 3 and then Fig. 1.

Your diagrams needn't be perfect, but make 'em legible enough for our artist to re-draw. Use the same format we use in the magazine, and do provide a parts list. We'll need captions as well.

And of course, we need good, clear, black and white photographs. These must be captioned as well, although photographs (as you'll see) do not take figure numbers.

Programs (if they're needed) should be run off on a printer with a new ribbon, as we reproduce yours exactly. Keep the width to three and one-half inches, please, and proofread carefully before sending it in.

After the editors review the article, if you've done a good job, you'll be getting our check in payment for it, and some months later (there's a lot of lead time) you'll be seeing it in print, yes, with *your name* on it! You're an author!

Byron G. Wels

Byron G. Wels
Editor

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LETTERS

Light Chasers?

I read the Remote Power Controller article with great interest. Properly programmed, couldn't this be used to control disco lights? I'm not a programmer myself, but couldn't somebody come up with a suitable software package for this?—D.S., Ventura, CA.

Okay you guys, get busy!

Pay your money...

In all honesty, I must say the computer is highly overrated. At my family's insistence, we bought one and now it's used mostly for playing games, when it's used at all. There are a lot of other things I could have used that money for and feel I should have done better by investing in a few video games at a much-lower cost.—S.D., Wayne, NJ.

See the letter that follows.

And take your choice.

Our family computer has become the hub and center of our activity. It's truly a solution looking for problems! And the more we use the thing, the more applications we find for it. Frankly, I can't see how we ever got along without it in the past, but we're sure glad it's here now!—R.L., Washington, D.C.

See the preceding letter.

On our projects

I've seen some of the projects in **ComputerDigest** that I'd like to build, but have never tried my hand at constructing *anything* electronic. Is it hard to do?—T.J.—Austin, TX.

Start with something simple, and get the feel of wire-wrapping as a starter. Once you get your feet wet in this field, and have a success or two, there'll be no stopping you.

Computer Power

I'd like to know what others are doing about controlling power to their computers. My on/off switches are inconveniently located on the backs of the units. S.R., Eugene, OR.

S.R., we've seen some pretty-sophisticated power controls, but many of 'em bring along as many problems as they solve. Most of us use simple, switched, multiple outlet strips. Not fancy, but very convenient.

Glare

I have a glare problem with my monitor screen and have seen those glare-reducing panels. Do they work? Do you think it is a worthwhile investment?—F.K., Boise, ID.

Some people like them, others don't. I use one all the time. It eliminates glare, makes the blacks blacker, and I wouldn't be without it. It seems to be a matter of personal taste.

More To Learn

There's so much more for kids to learn these days! Shouldn't our educational system be modernized?—R.T., Reno, NV.

You've hit on one of my "hot buttons!" At one time, back in the 20's, there were only two branches of engineering—Civil or Military. You could count the number of countries in the world on the fingers of both hands. These days, when a book is written, it's obsolete before it's published! Yes, there's a lot more to learn today, yet no more time is allotted to that learning. I don't know what the answers are, but we'd better start seeking them out before it's too late.

Free Advice

Is usually worth its cost. But I've been offered a job in the computer industry and have been told it's a "dead-end" job that offers a good salary, security, but absolutely no advancement. Should I take that job?—S.B., San Remo, CA.

I say take the job! There are no dead-end jobs, just dead-end people. As long as you can learn, it will be worth it.

SOFTWARE REVIEW

pfs: WRITE—Simplified word processor

■At last count there were some 1000 word processing software packages for personal computers. Most of them were so complex and confusing that they required hours of practice and study before they could be implemented. On the other side of the coin, is Pfs:WRITE, a simplified word processor that can be learned in about 30 minutes and which can directly integrate data from inventories and filing systems into business correspondence and documents: Essentially, a program tailor-made for the technician and small service shop.

Perhaps the biggest advantage however, is that this program is just about designed for your own needs without requiring any compromise on your part. It's easy to learn, and once you *do* learn it, it's ready to go to work.

Unlike the word processors designed for producing long documents, pfs:WRITE is intended for business correspondence, reports and memos or customer notices. Preparation of the mailing envelope is handled as a part of a document's preparation. Conventional methods require the envelope to be prepared independently of the document. You must use a separate envelope format, or make a separate run of mailing labels to be affixed to envelopes for that "junk mail" look. The pfs:WRITE system has none of this. The print mode automatically determines the recipient's address from the position of the document's date, automatically prints the envelope correctly, and then returns to the document format. Even the automatic addressing is unusual. The program prints the entire address regardless of its length. Doesn't matter if it's two lines or eight lines, the address is printed with no blanks where address lines are "missing."

The program's operating mode is selected from a MAIN MENU that provides 1) Type/Edit; 2) Define Page (how the document appears on the screen); 3) Print (with separate print menu); 4) Get/Save/Remove (a disk file); 5) Clear (erase current document from memory); 6) Proof (Integrated optional spelling checker) and 7) E) Exit (Leave program).

Documents are created or merged (boilerplate) in the Type/Edit mode, which creates the screen image of a page in a typewriter complete with a ruler line at the bottom. The displayed text closely resembles the actual printed copy on a line-by-line basis, including centering of the individual lines. Page breaks (bottom of the page) are shown, and a status line under the ruler indicates the actual page number and the line number of the cursor. The text itself is created and edited using conventional overwrite, insertion, deletion, paragraph moves and boilerplate insertion. While word or line deletions are "permanent" in the sense that they cannot be undone, anything marked as a block can be deleted and then recalled if necessary because marked blocks are stored in a "block buffer"—a reserved area of the computer's memory—from which the block can be recalled, moved or copied. The capacity of the block buffer depends on the particular version of pfs:WRITE. The MS-DOS version has a 100-line capacity, other versions have less capacity. If you try to move or copy more than the rated block capacity only the first 100 lines will be held in the block buffer. The remainder is lost unless the block is divided into manageable segments of less than 100 lines.

The Define Page mode sets the page parameters—how the document appears on the screen—and also permits insertion of a two-line header or footer, with pagination in the second line of the footer. Both can be positioned (L, R, C) independent of the general page format, and both can be programmed not to print on the first page of the document.

Both underline and boldface are built into the program, along with a simplified means to insert any number of printer control commands anywhere within the document, either during or after preparation. A primary set-up printer control code(s) can be programmed as part of the print routine.

The print mode operates through its own menu, which among other features permits user selection of the kind of printer, page pause, number of copies, page indent, justified margins, automatic printer set-up codes, and integration from the pfs:FILE program. Any data at all, of any kind, that is stored is a pfs:FILE data file can be inserted in a pfs:WRITE document. It could be names and addresses (not unusual), or a reminder to a customer to renew the service policy on his TV or VCR. If it's stored in a pfs:FILE it can be programmed with unusual ease to be automatically merged into the document.

Unforunately, the print routine has a quirk that can effect non-business documents. It's line spacing conforms to the conventional business practice of using the same general spacing for the entire document. Although the user can select either single or double line spacing, unlike most other word processors, they cannot be combined. pfs:WRITE cannot print double spacing and have text insertions that are single spaced. You can have single spacing with double spacing generated when the document was created, but not vice-versa. On the other hand, the MS-DOS version of pfs:WRITE does allow indenting and justification independent of the general page format.

pfs:WRITE is exceptionally easy to learn and use. There are only 20 commands, all of which appear on a help screen. It is, in fact, possible to run the program directly from the help screen. The manual (at least the MS-DOS version) is a gem, once again proving the rule that "The thinner, the better."

pfs:WRITE—Software Publishing Corp., 1901 Landings Drive, Mountain View, CA 94043.◀◍▶

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

SURGE SUPPRESSOR, the *SL IV*, is a multi-outlet device deigned to protect computers and other microprocessor-based equipment from overvoltages.

The model *SL IV* offers non degrading, permanent protection within operating parameters, and effectively eliminates computer downtime, component damage, and nuisance failures caused by transients. It also features a 15-amp circuit breaker with reset switch, status-indicator lights for the circuit breaker and suppression circuitry, and three high-quality grounded receptacles, which accommodate most CPU/printer/

CIRCLE 11 ON FREE INFORMATION CARD

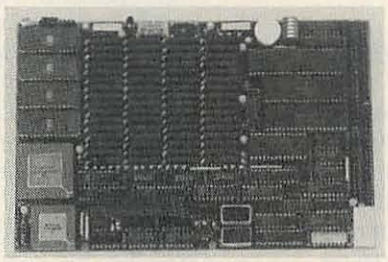
CRT configurations and other multi-plug setups.

Any computerized equipment system drawing up to 15 amperes is appropriate for protection by the model *SL IV*; that includes microcomputers, computer terminals, intelligent photocopiers, electronic cash-register systems, memory typewriters, and medical analysis equipment.

The model *SL IV* is priced at $224.00—**Transtector Systems, Inc.,** 10701 Airport Drive, Hayden Lake, ID 83835.

SINGLE-BOARD COMPUTER, the model *GMX Micro-20*, combines a Motorola MC687020 32-bit microprocessor and an optional MC68881 floating-point coprocessor with 2 megabytes of 32-bit wide RAM, up to 256 kilobytes of 32-bit wide EPROM, four serial ports, an 8-bit parallel port, a 5.25" floppy disk controller, a SASI peripheral interface, and a clock with battery backup. 16-bit expansion connector allows the addition of off-the-shelf or custom I/O interfaces.

The board, measuring 8.8" × 5.75", mounts on and uses the same power connector and supply voltages as a standard 5.25" disk drive. Power requirements are +5-volts DC at 4.5A max., and +12-volts DC at 125Ma. A



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separate board, included with the model *GMX Micro-20*, provides RS-232 level translation, and 4 DB-25 type connectors for the serial ports. A DC-to-DC converter supplies the −12 volts.

The model *GMX-Micro-20* is priced at $27.50.—**GMX, Inc.,** 1337 West 37th Place, Chicago, IL 60609.

WORD-PROCESSING SYSTEM, is an enhanced version of Timeworks Inc., *Word Writer 128* program for the Commodore *128* computer.

The upgraded *Word Writer 128*, an 80-column professional word-processing system for home and business use, works in C-128 (128k) mode with either a 40- or 80-column monitor. Additional features now include On-screen highlighting, right-margin justification, superscript and subscript, headers and footers, and speed keys for more experienced users.

On-screen highlighting allows the printer to underline, italicize, boldface, or use all three together at the press of a key. It also allows the user to see each highlight on-screen before hard copy is printed. *Superscript and subscript* displays and prints numbers in superscript or subscript for fast footnote references. *Headers and footers* displays

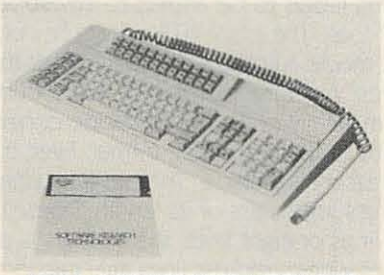
CIRCLE 13 ON FREE INFORMATION CARD.

and prints headers and footers throughout the user's document, as commanded. *Speed keys* let the user access *Word Writer* commands quickly, using a minimum of keystrokes.

The *Word Writer 128* already includes an 85,000 word-spelling checker, a built-in 5-function calculator, "pull-down" menu technology, and a full-screen format. It can be used by itself, or interfaced with Timeworks *Data Manager 128, Swiftcalc 128,* and *Sylvia Porter's Personal Financial Planner.* Each of those programs carry a $69.95 retail price. Backup disks are available for Timeworks' registered users for $14.70.—**Timeworks,** 444 Lake Cook Road, Deerfield, IL 60015.

ENHANCED KEYBOARD, *Style 3270,* has 126 keys and is designed to go with *SmartKey* 5.0 Keyboard Enhancement software.

The *SmartKey* software allows the user to redefine the keyboard for specific needs. It also defines special 24 function keys to the user's use and simplifies complex commands by defining single key macros.



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The *Style 3270* keyboard is PC compatible. It sends IBM PC synchronous format and responds to handshake and reset signals from the IBM PC and XT. Additional features include: Cherry MX full travel gold crossbar contact configuration key module; full N-key rollover with auto-repeat and chassis ground.

The unit is 1.133" from enclosure base to center point at home row-keycap top. It also has keyboard micro with 16-deep FIFO and scanning phase in the event that FIFO is filled.

The *Style 3270* enhanced keyboard is priced at $195.00. With *SmartKey* software included, the price is $245.00 complete.—**Cherry Electrical Products Corp.,** 3600 Sunset Avenue, Waukegan, IL 60087.

MORE ON MODEMS

When your modem won't talk...

Herb Friedman

■A modem is the easiest peripheral to interface with a personal computer. You simply connect them together through matching plugs and everything works. But theory falls down before practice when the software becomes sophisticated, or a manufacturer has taken short cuts and left out circuits because "the average user probably won't ever need them." Unfortunately, it often works out that the circuit, wire, or signal indicator that's "missing" or unconnected is the one that's required by your software or the computer itself.

Although virtually all conventional RS-232 I/O modems utilize the 25 terminal subminiature D-connector, it takes only three connections from your computer to its modem to establish communications using a non-automatic modem. At the computer itself these connections are usually labled as TD (transmit), RD (receive), and "common," which is always terminal #7. Although there is supposedly a "standard," TD can be terminals 2 or 3, and RD can be terminals 3 or 2. (Some manufacturers use Tx for RD and Rx for TD—and don't ask why.)

Much mumbo-jumbo has gone into describing the TD and RD connections because the original RS-232 "standard" was murky on the subject. When connecting a personal computer to a modem it's easy to keep track by remembering that TD, or transmit, means the *output* signal *from* the computer, while RD means the *input* signal *to* the computer. Unfortunately, you will find the modem's connections are probably also labled TD and RD, so what do the connections represent at the modem? Whether at the computer or the modem TD means the computer's output signal and RD means the computer's input signal; connect the computer's TD terminal to the modem's TD terminal and the computer's RD terminal to the modem's RD terminal.

Straight-across wiring

If a computer's RS-232 I/O connections are intended for connection to a modem the wiring order of the connections is called DTE and will be what is called "straight across," meaning computer terminal #2 connects to modem terminal #2, computer terminal #3 connects to modem terminal #3, etc.

The problem comes in when the computer's serial I/O has connections intended for a printer, the so-called DCE wiring order. The functions of DCE terminals #2 and #3, among others, are reversed; if you connect

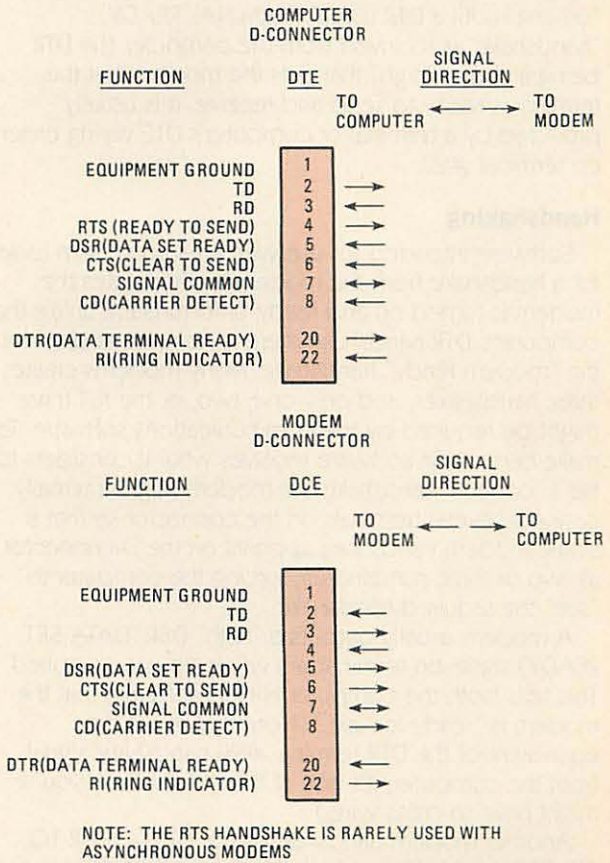

FIG. 1—ALTHOUGH THE DTE AND DCE wiring order uses the same descriptive terms for the functions, the signal direction is completely opposite.

DCE computer terminals "straight across" to the modem nothing will happen because neither the computer nor modem will know what's going on. The way out of the DCE/DTE bind (if you don't know what goes where) is to match the TD and RD terminals on the computer to the modem, which means "crossing" the connections, that is, connecting DCE computer terminal #2 to modem terminal #3 and computer terminal #3 to modem terminal #2. Make a copy of Figure 1, which shows the differences between the DCE and DTE wiring order for RS-232 D-connectors.

Modem communications would be simple if all you had to do was match the TD and RD connections, and, this is all you have to do with an acoustic modem, where you dial up the remote computer and place the telephone's handset in a pair of cups on the modem. But much modern software, and some modems, won't work with such a simple connection because they require some form of electrical "handshaking," meaning an electrical signal that informs either the modem, the computer, or both that the other device is ready to receive data. Depending on the particular software used, handshaking might be required from both acoustic and direct-connect modems—the kind that's "permanently" connected to the telephone line: and handshaking is generally needed when using an *automodem*—the kind that can automatically answer a call or dial out. For example, to prevent an automodem from answering every ring they are generally designed—or programmed by a switch—not to go "on-line" until a DTR (DATA TERMINAL READY) "handshake" is received from the computer, the DTR being a digital "high" that tells the modem that the terminal is ready to send and receive: it is usually provided by a terminal or computer's DTE wiring order on terminal #20.

Handshaking

Software intended for use with an automodem looks for a handshake from the modem that indicates the modem is turned on and ready, unfortunately, unlike the computer's DTR handshake there is no real standard for the "modem ready" handshake. Many modems create three handshakes, and only one, two, or the full three might be required by the communications software. To make certain the software receives what it considers to be a "correct" handshake the modem might internally connect several terminals on the connector so that a single modem handshake appears on the D-connector as two or three handshakes, forcing the computer to "see" the required handshake.

A modem usually outputs a "high" DSR (DATA SET READY) signal on terminal #5 when power is applied. This tells both the computer and its software that the modem is "ready for use." (Note that this is the equivalent of the DTR terminal #20 handshake signal from the computer; it's one of the connections you might have to cross-wire.)

Another modem handshake is the CTS (CLEAR TO SEND) "high" from terminal #6. This handshake can be used for just about anything, but for personal computers it is often combined with the CARRIER DETECT (CD) "high" from terminal #8 by a simple shorting wire.

The CARRIER DETECT is the handshake that modern communications software is looking for because the CD "high" is generated only when the modem senses the "carrier tone" produced by the modem at the remote computer. Because reception of a carrier means the modem is actually "talking" to the remote computer, the CD "high" is often used as the "master handshake" for the computer, so it is often internally connected within the modem and also appears as the CTS (CLEAR TO SEND). If a carrier tone isn't being received the modem isn't talking to the remote computer, hence, it is not clear for sending data from the computer. (There really is a logic to all RS-232 connections when they concern a computer and a modem—not a printer.)

If the software is only looking for a "modem ready" handshake it might check only the the CTS and CD handshakes. However, some software intended for use with automodems won't do anything until is "sees" the DSR (DATA SET READY) handshake, the reason being that the software automatically downloads programming for the auto-modem's internal microprocessor, forces the modem to go "on-line," and causes the modem to dial only when the software sees through the DSR handshake that the modem is actually turned on. After dialing, the modem will time-out reception of the CD handshake. If it doesn't receive a CD handshake within a specified time period it will disconnect the modem or disconnect and redial.

Although software can force a Hayes-compatible automodem to go off line by transmitting a command code such as ATH0 (meaning the modem should go "on hook"), some software causes an automodem to disconnect by forcing the computer's DTR handshake "low." The modem sees the low, assumes the computer is turned off, and drops off the line. But a problem can arise when using the DTR to disconnect the modem from the telephone line because not all software and/or computers support (provide) the DTR, and not all modems which claim to be Hayes-compatible respond to the DTR; they go disconnect from the telephone line only if a direct ATH0 command is received from the computer. If either the computer or the modem don't support the DTR, and the software—or the user cannot provide an ATH0 command—the modem literally gets "stuck" and won't disconnect unless its power supply is physically turned off.

Handshake signals always appear at the same modem terminals if the modem employs a conventional 25 terminal D-connector. (The D-connector is only a general "standard" for convenience; some manufacturers of external modems employ proprietary connectors.) D-connections at the modem are always DCE and are wired as shown in Figure 1. On the other hand, computers can have either a DTE or DCE wiring order. If they are DTE the connectors are wired, as previously mentioned, "straight across." But if the computer's serial I/O is wired DCE then several wires—not just the signal pair—must be crossed if full handshaking is to be attained. Your computer or the software might not require all the handshakes provided

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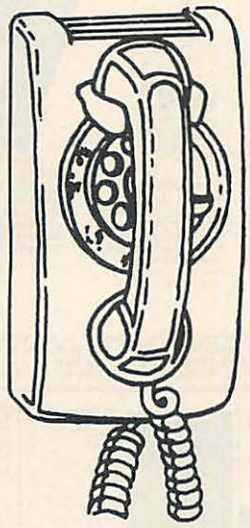

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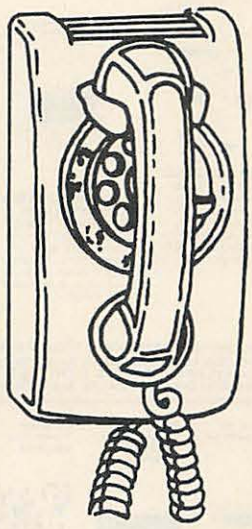

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by the modem. If all the software wants is a "modem ready" handshake before it transmits data, then just the DSR—meaning modem power is *on*—would be adequate, although the CD is preferred because then the software knows for certain that it is linked up with another computer. There is much software around that appears to go on-line when it's actually working into an unconnected modem because the software is responding to the DSR handshake, which only means the modem is powered—that's all.

If it still won't work

If everything is connected together and the modem still won't work with the computer, doublecheck the modem's DSR and CTS terminal connections. Somewhere along the line the DSR and CTS got tangled and the Hayes and some Hayes-compatible modems combine the DSR and CD handshakes, using the CTS as the "power on" handshake. It makes no difference whether DSR or CTS is connected to the CD, but *usually* doesn't mean *always*.

Finally, there is the modem's RI (RING INDICATOR) handshake on DCE terminal 22, which is intended for use by software that controls automodems. The RI is a "high" that indicates a telephone is ringing; it causes the software to force the modem to go "off hook" (to connect to the telephone line).

As a general rule of thumb, the more sophisticated the software the greater its use of handshaking with the modem, so when you can't get a computer to talk to its modem check that the various signal and handshakes go to the right terminals on both the modem and the computer before you start looking for glitches in the software. More often than not the problem is usually one or more "reversed" connections.◀CD▶

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PROTOCOL CONVERTER

Allow X-on/X-off devices to interact with lead-control devices.

R. L. L. Hu

■When physical differences exist between devices, special adapters and interface converters can resolve the problems of electrical and mechanical interconnection (for example, interfacing between RS232 and RS422 circuits which differ in signal level and connector size). However, when logical differences exist, then a protocol or code converter is required. Protocol and code converters are used in situations where communication between devices cannot proceed due to lack of comprehension of each other's data. They "bridge the gap" for differences in transmission mode, transmission code, communications protocol, etc.

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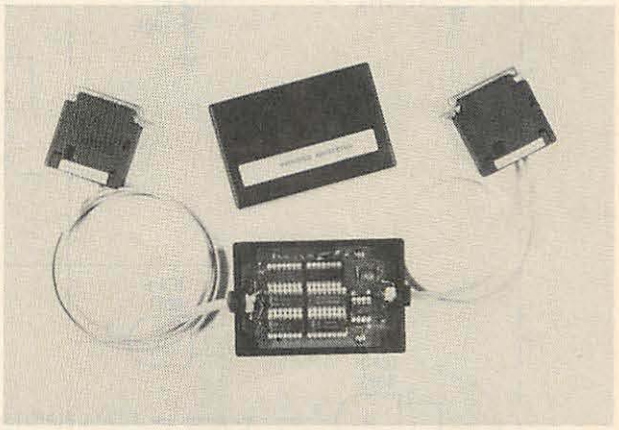

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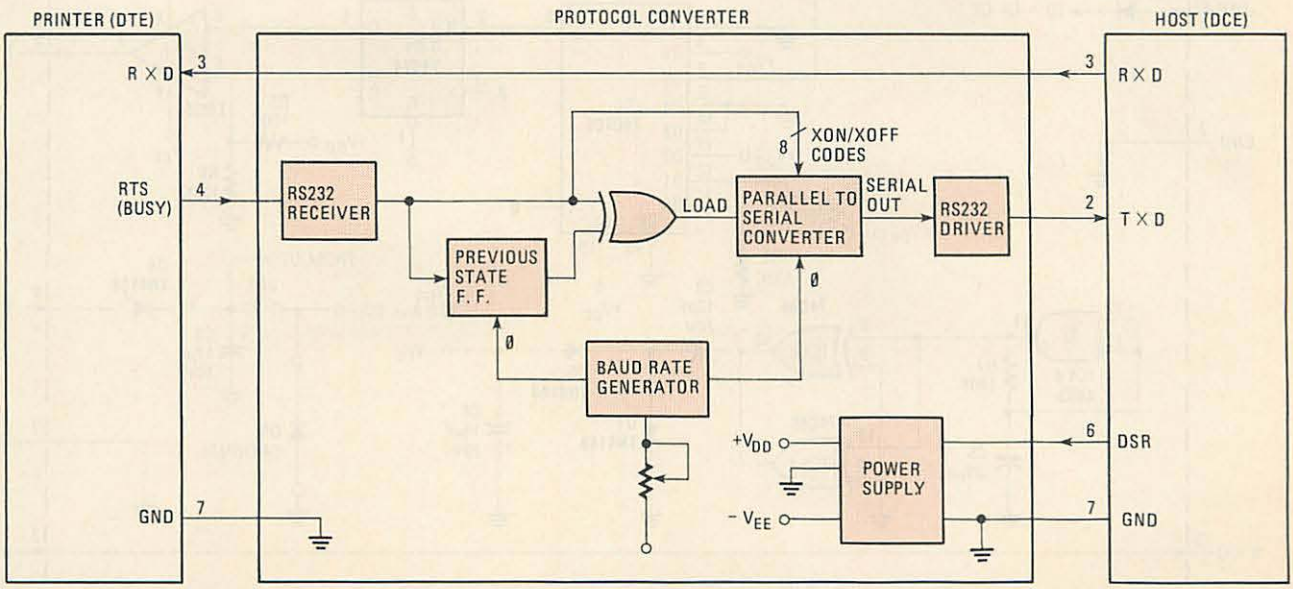

FIG. 1—BLOCK DIAGRAM provides an easy means to overview the circuit and gain sufficient grasp to make it easy to understand. See text.

more reliable operation. Notable features of this project are that it is powered by the RS232 signal lines and it does not even use a UART or ACIA chip! The whole circuit is built using standard digital CMOS chips.

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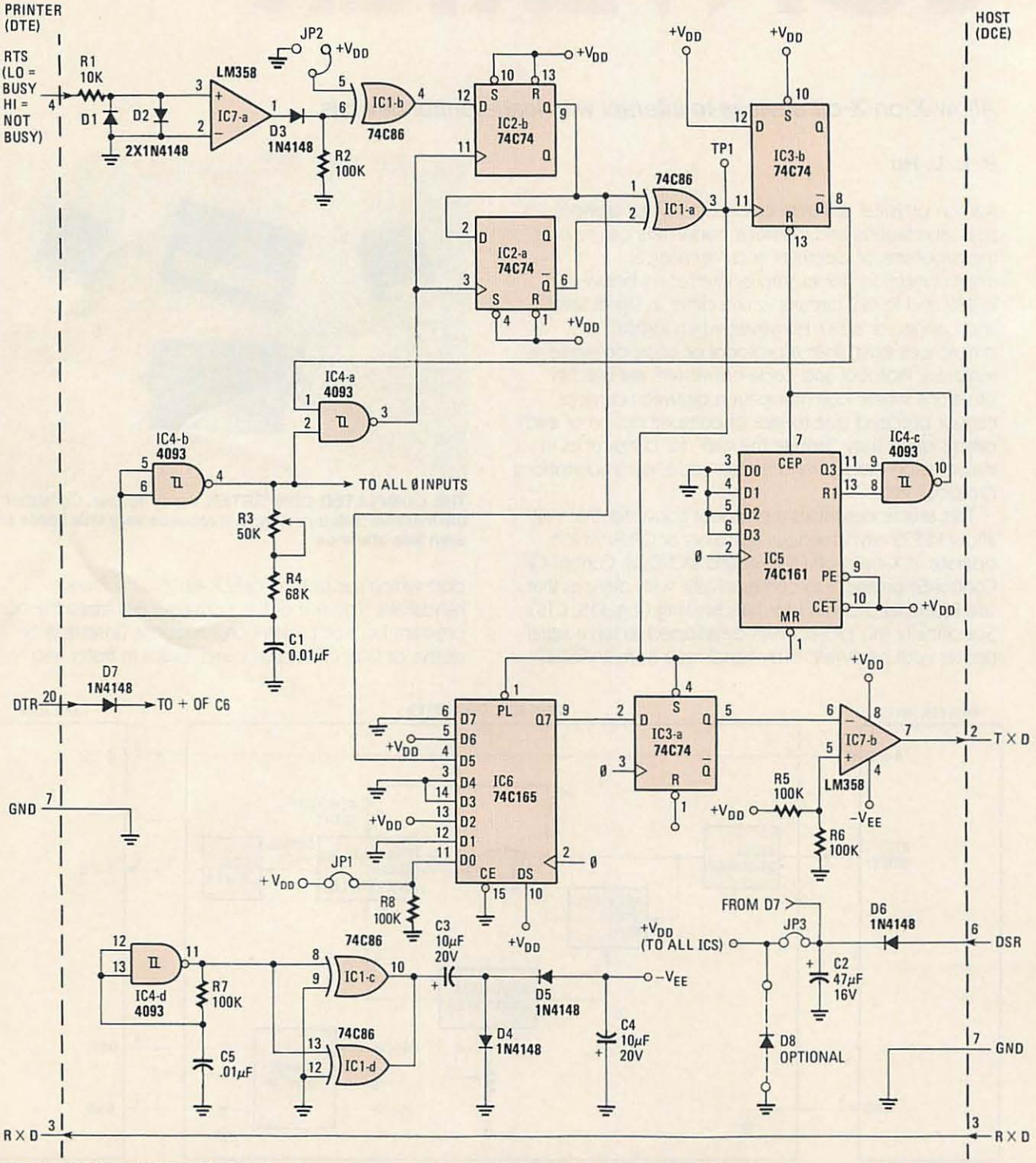

FIG. 2—SCHEMATIC DIAGRAM of converter. Note that the printer side is shown at left, the HOST at right. Text will clarify the schematic for you.

TOUCHSCREEN TECHNOLOGY

Something new has been added...

Marc Stern

■Based on surface acoustic wave (SAW) technology, the Zenith system relies on piezoelectric elements to generate SAWs. Acoustic reflector strips on each edge of the tube face send the SAWs across the screen and an invisible matrix of touchpoints is created. (See Fig. 1)

When the matrix is broken by a touch, an amplitude dip is created. The timing and depth of the dip indicates the location and pressure of the touch.

This concept was first developed in the early 1970s in a system which used a set of parallel SAW beams, in the same manner that infrared LED touch systems are used today. Rows of transducers are placed on opposite edges of a glass panel and are cycled; one transmit-receive set is turned on at a time. In this system, transmission attenuation on one of the possible paths determines the position of the touch.

The need for transducers along a minimum of two edges imposes a cost penalty. To reduce costs, Zenith rethought the concept and borrowed from reflective array technology to complete its acoustic touchscreen. The reason it proved attractive enough for Zenith's work is its good signal-to-noise ratio and the absence of spurious reflections or transducer ringing.

Using a single transducer in the upper left corner of the touchscreen panel, a short burst of SAWs is

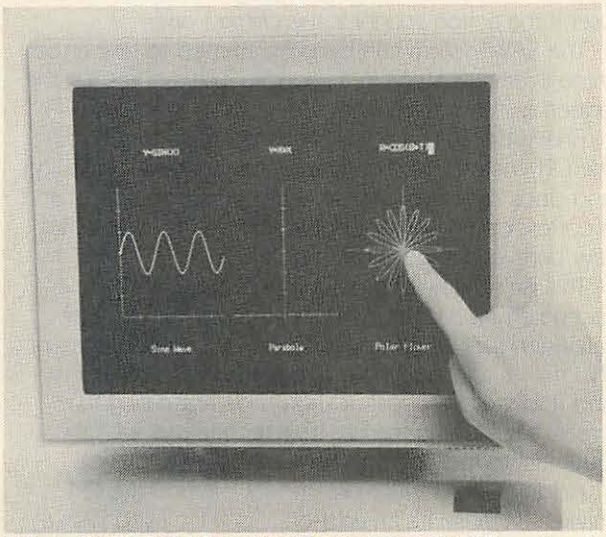

FIG. 1—THE ZENITH ACOUSTIC TOUCHSCREEN system is the first to offer three-dimensional touchpoints. It uses acoustic wave technology to create a matrix of inaudible soundwaves across the tube face, providing a depth coordinate as well as vertical and horizontal points.

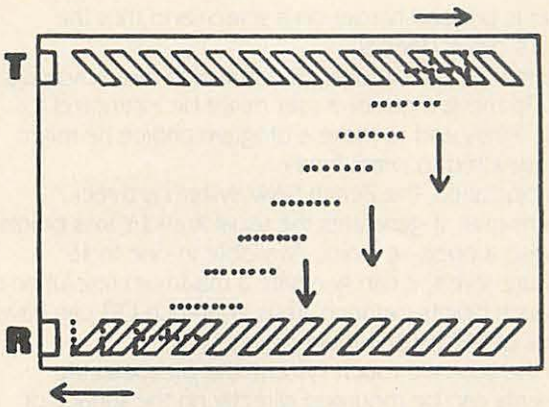

FIG. 2—USING ARRAY TECHNOLOGY, the Zenith system relies on a transmit transducer and an upside-down mirror image receiver to produce an acoustic wave system that bathes a CRT screen system with soundwaves. It is used in the horizontal and vertical plane.

emitted. Traveling along the top edge of the screen, the SAWs run into an array of partial reflectors, positioned 45 degrees to the direction of wave travel.

Wavelets

This array produces wavelets which travel vertically down the face of the screen. Because of the positioning of the reflectors, wavelets coming from reflectors farther to the right lag behind those which are reflected further to the left.

Eventually, this train of wavelets reaches an upside-down mirror image of the upper array at the bottom of the screen panel. The wavelets hitting the receive array are directed toward the receive transducer to the left. Note that the later wavelets produced to the right are further delayed by a longer return path. (See Fig. 2)

The planned delay of wavelets produces a continuous signal with a long rectangular envelope. The screen panel is covered by a continuous flow of wavelets with different transit times and each point on the time axis corresponds to a specific vertical path along the screen panel.

The attenuation dip caused by a touch appears in the output signal and indicates the position.

This system uses a fixed frequency in the 4 to 10 MHz range. The signal must be weighted so the amplitude of the signal remains constant across the screen panel, rather than decreasing exponentially over time. The designers, therefore, lowered the reflectivity of the array closest to the transmitter, where the signal is the strongest and used the highest reflectivity available at the other end.

Because of technical considerations, such as the SAW's velocity on soda-lime glass, it was found the optimum placement of the reflective elements is 0.75 mm, positioned at 45 degrees. In the perpendicular plane, spacing is 0.53 mm, or half a wavelength. A 50 percent duty factor means the strips should also be 0.27 mm wide. They are 5 microns thick. Therefore, the reflective elements can be screen printed on a panel.

Pressure dependable

A surface wave will be more deeply attenuated as a

finger is pressed harder on a screen and thus the signal's dip is deeper.

Functions can be designed in which take advantage of it. To move a cursor a user might be instructed to press lightly and to make a program choice he might be instructed to press firmly.

In operation, the Zenith SAW system is three-dimensional. It generates the usual X and Y axis points, but also a pressure point. Available in one to 16 pressure levels, it can generate a maximum resolution of 50 touch points per inch. Thus, a 14-inch CRT can have a total of 512 by 384 touchpoints.

In the acoustic touch system, the piezoelectric elements can be mounted directly on the surface of the cathode ray tube or they can also be placed on a glass overlay. When they are excited electrically, they emit SAWs, which are reflected off the reflective strip arrays mounted along each edge of the tube surface. They send the SAWs across the screen and create the invisible matrix of touchpoints.

When a finger breaks the sound waves, two or more transducers sense it and a microprocessor locates the sources of the break at its horizontal and vertical crosspoints. And, because SAWs are affected by the amount of pressure applied, this system can not only generate the traditional X and Y information common to other forms of touch systems, but also a Z or third positional input that is based on pressure.

Three-dimensional

Because it can generate an extra dimensional input, it is possible for the SAW system to be more versatile than the standard touchscreen system. Most standard touchscreen systems can generate touchpoint resolutions from 1,024 by 1,024 to nearly 4,000 by 4,000, but these are only two-dimensional (X,Y) inputs which, while they do yield good positional inputs, fail to yield any other information. Adding the pressure or Z axis allows a company to build in more functionality because a system cannot only place the touchpoint in space, but it also has a pressure reference which can serve another function.

The resistive-membrane system is the more common type. It's been used for years and relies on a grid of resistive elements. When the elements are pressed a current corresponding to the X and Y axes is generated.

Generally transparent, the typical resistive or resistive-membrane touchscreen may have a layer of dots sandwiched in its construction. Although these dots are largely for show, they help a user locate where an input is generated. The resistive element is the important piece of the sandwich and it is a transparent layer of metallic material that has been included in the membrane's construction. When this comes in contact with a second element a current from a touchpoint is generated and a microprocessor senses the input.

The drawback with is that it cuts down on the visibility of a CRT because of the number of layers that are superimposed on the glass.

A resistive system relies on the current between a fingertip and the resistive element on glass. Since it becomes part of the glass, it can be clearer than the traditional resistive-membrane system. It is less prone to damage from sharp instruments.

FIG. 3—THE SAW SYSTEM is highly versatile. It can be integrated with a graphics tablet to control a personal computer or terminal.

The second type of touchscreen technology works in a similar manner to the acoustic wave, except that it uses banks of LEDs and infrared detectors. In this system, LED transmitters are placed along the X and Y axis and receivers are placed opposite them. The LEDs transmit vertically and horizontally, from the bezel surrounding the CRT screen, and where a fingertip interrupts the LED beams input is generated.

This type of system will generated an X-Y position, but is incapable of generating a third dimension.

More flexibility

The Zenith system is important because of the added flexibility it gives to a touchscreen system. A system can be programmed to recognize the increased pressure and can then ask if a user would like to take a new or extra action. It can be programmed to ask a user if the action sought is the correct one.

The SAW system can be programmed to take a user through several steps in a program just by pressing the screen a little harder.

Finally, because it relies on transducers surrounding the CRT, there is no diminution of the screen's visibility and since only two piezoelectric sensors are used and a corresponding number of receivers, the system has few parts and should be trouble-free.

This isn't the first time Zenith has used SAW technology. It has used this technology for years in television sets. It's the novel approach in touchscreens that makes it interesting and because of its reliability and relatively low cost, it should be appealing to broad areas of the market. It's a technology with the potential to reshape the market in its own image.

Additionally, it will have impact beyond the CRT market. Because it's an add-on, it can be used with a wide variety of products. For example, it can become part of a graphics tablet package (See Fig. 3). This will allow the user fingertip control of a computer. It's just another use of this versatile technology.◀CD▶

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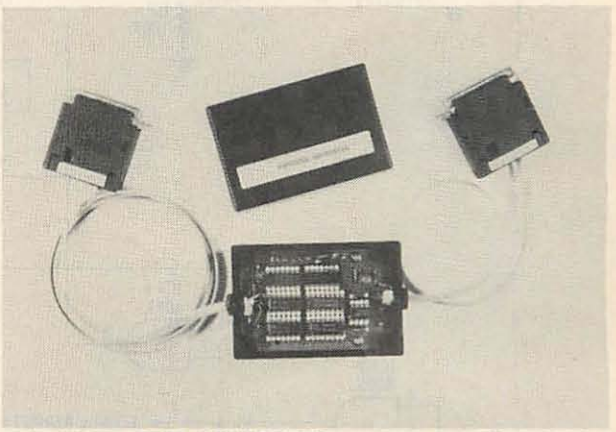

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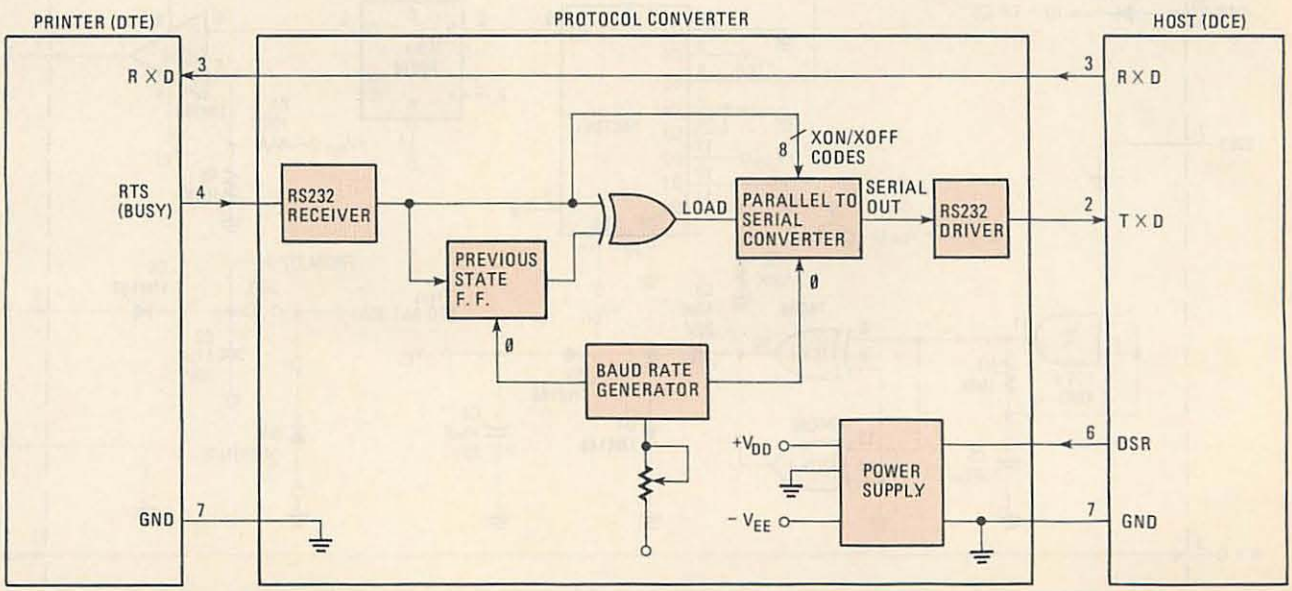

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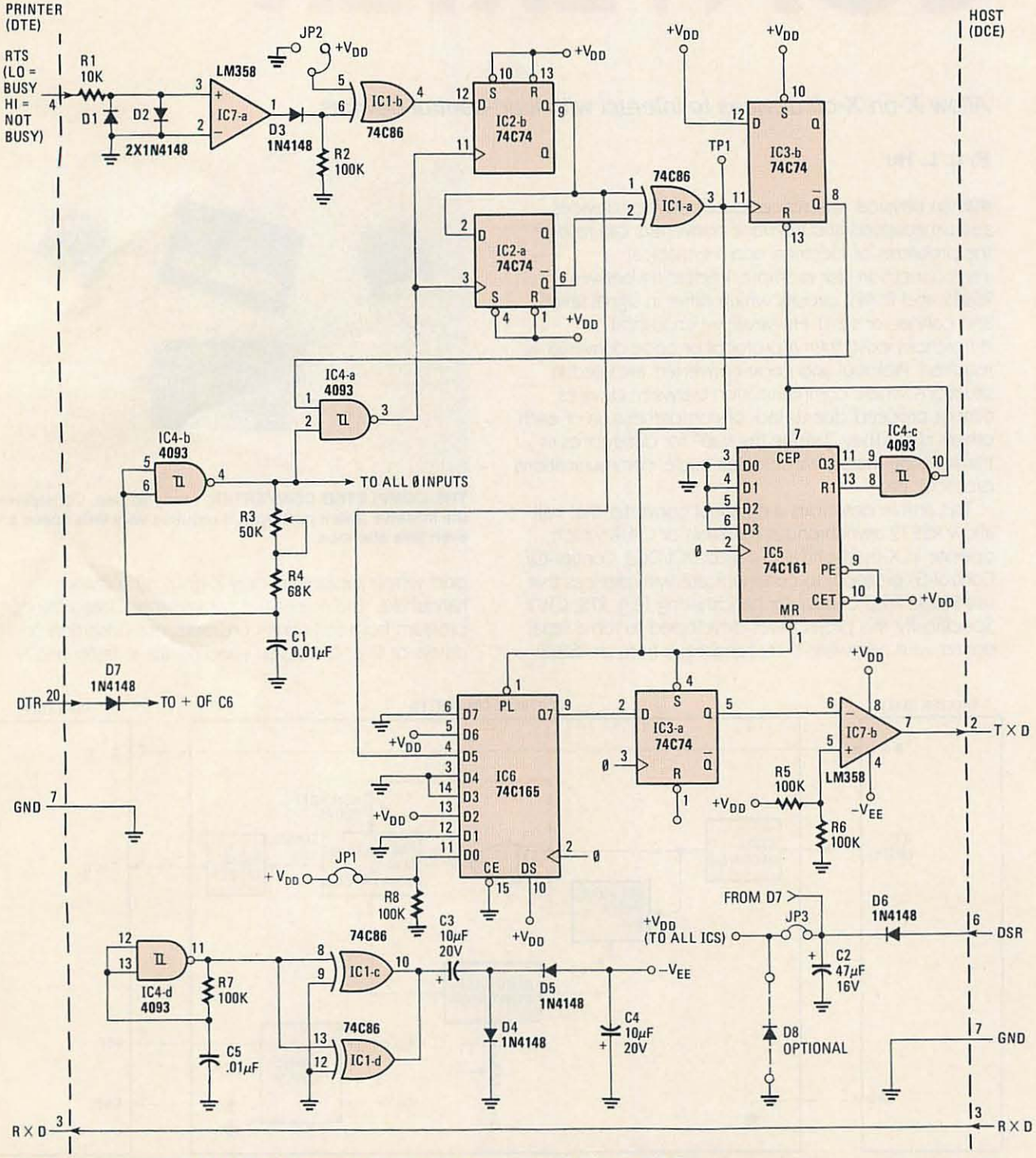
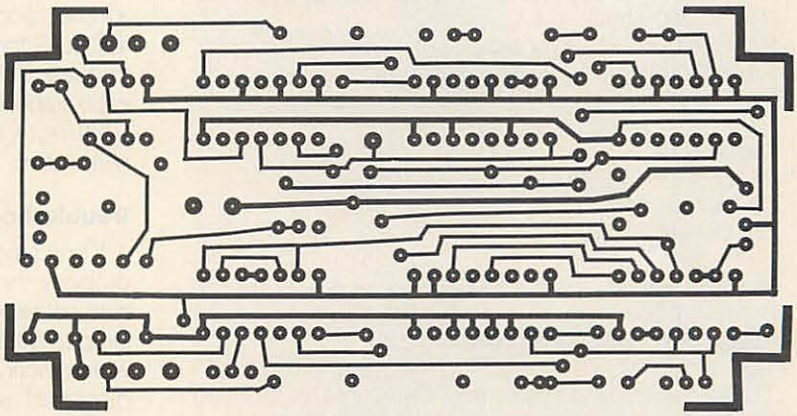


FIG. 2—SCHEMATIC DIAGRAM of converter. Note that the printer side is shown at left, the HOST at right. Text will clarify the schematic for you.

is accomplished in the converter. Serial data from the host is passed directly to the printer. The BUSY line from the printer is, however, first fed to the converter. The converter then sends the appropriate control code to the host unit, but only when there has been a change in the BUSY line state. The changes in states are detected by "remembering" the previous BUSY state and comparing it with the present BUSY state.

Now look at the schematic diagram, Figure 2, for the following detailed description. The power for this converter is derived from an active RS232 control line, the usual choices being DSR or DTR. D4, D5 and C3, C4 form a voltage inverter which is powered by the oscillator/driver combination of IC4d and IC1c and d. This generated negative supply voltage is used by the op amp IC7b, to drive the RS232 line to the host.

The baud rate clock is built using a Schmitt Trigger, IC4, making possible a simple and reliable oscillator with only a resistor and a capacitor. This eliminates the need for the more-expensive crystal and baud-rate generator chip. The baud rate clock was set to run at 2400Hz (2400 baud) in the prototype unit. This baud rate can be changed by using different values for R4 and C1. Just make sure to set the same baud rate on the



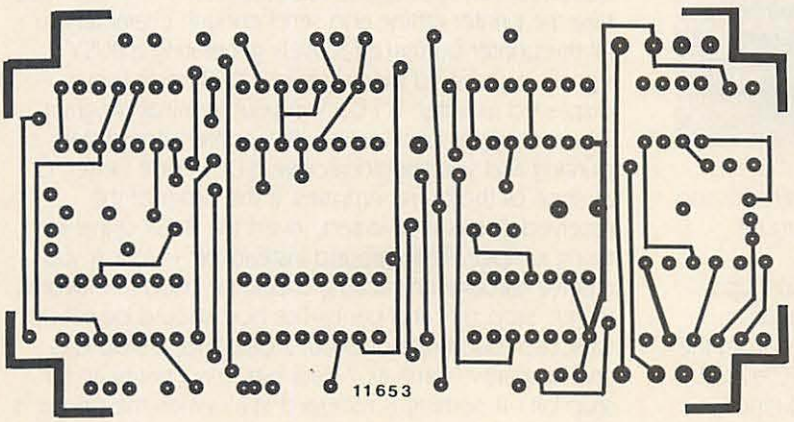


FIG. 3—THE PC BOARD is shown above (solder side, component side to left) full size for those who desire to fabricate their own boards. See parts list for name and address of source for completed circuit boards. Solder side is above, component side to the left.

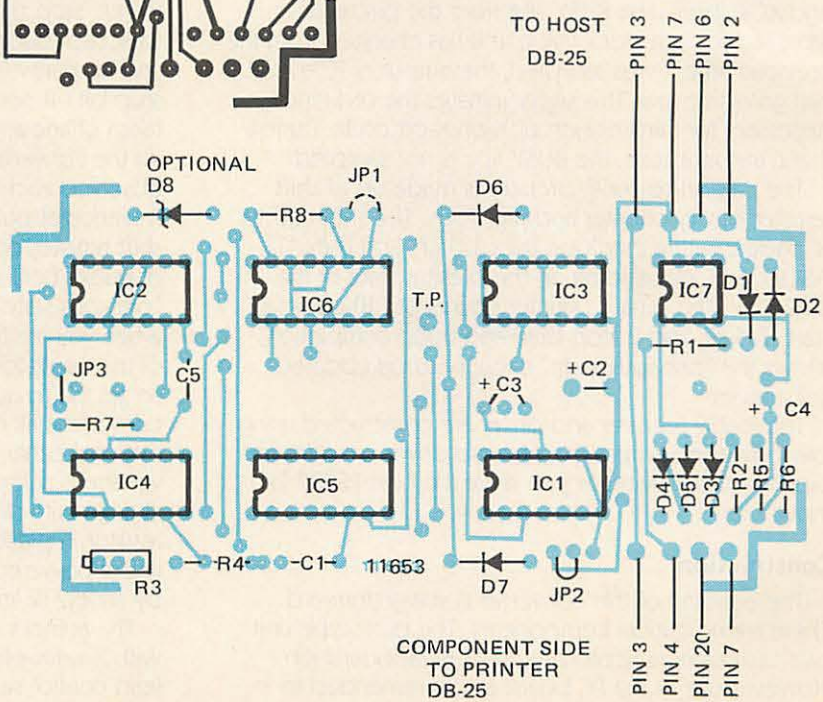


FIG. 4—PARTS PLACEMENT DIAGRAM, component side of board.

PARTS LIST

Semiconductors
D1-D7—1N4148 Diodes
D8—1N5236B Zener, 7.5V (optional)
IC1—74C86 XOR Gates
IC2, IC3—74C74 Flip-Flops
IC4—4093 Schmitt Triggers
IC5—74C161 Counter
IC6—74C165 Shift Register
IC7—LM358 Op Amps

Resistors
All resistors ¼ watt, 5% unless otherwise specified
R1—10,000 ohms
R2, R5-R8—100,000 ohms
R3—50,000 ohms, 10-turn potentiometer
R4—68,000 ohms

Capacitors
C1, C5—.01 μF, 50V
C2—47 μF, 16V
C3, C4—10 μF, 20V

Miscellaneous
PC board, hardware, wire, solder, Etc.
Plastic box (Radio Shack RS 270-221)

The following are available from Capulum Ltd., 814 Proctor Avenue, Ogdensburg, N.Y. 13669: printed circuit board, double sided with plated-through holes for $12. Assembled and tested unit, complete with connectors for $49. Add $2 for postage and handling. New York residents must add sales tax. Money order or Visa. (613) 726-1966.

host and the printer (while it is possible to transmit and receive at two different baud rates, nothing useful would be achieved here).

The "previous state" circuit is built using flip-flops and XOR gates. The BUSY line from the printer is sampled at each clock cycle. If it has changed from the previous time it was sampled, the output of IC1a XOR will go active low. This signal initiates the sequence necessary for transmission of X-on/X-off code. During these transmissions, the BUSY line is not sampled.

The parallel-to-serial circuitry is made up of shift register, binary counter and flip-flops. The shift register is loaded with either X-on (hex 13) or X-off (hex 11) ASCII code, depending on the present state of the BUSY line. The binary counter counts out 10 pulses (1 start, 7 data, and 2 stop bits) and upon completion, allows the "previous state" circuitry to be updated once again.

The RS232 receiver and driver are constructed using low power op amps. The op amp driver provides the bipolar output necessary to drive the host RS232 TxD input line.

Construction

The building of this converter is straightforward. There are no critical components. The prototype unit was built using a Scotchflex 3303 Breadboard Kit. However, use of the PC board is recommended to minimize construction errors and to save time. A layout for the printed circuit board is provided full size in Figure 3. See parts-placement diagram for location of components on the PC board (Figure 4).

Calibration

Connect the converter board to the host unit. Check the voltage level of +Vdd and −Vee. Note that the magnitude of the -Vee will be about 1.2V less than +Vdd, due to the two diode drops at the inverter circuit. Make sure the RS232 voltage levels do not exceed ± 15 volts; +15 being the recommended maximum voltage for operating the CMOS chips. Install a zener diode in the circuit if necessary. Check and adjust R3 for an oscillator frequency of 2400Hz. This frequency does not have to be very accurate, since each start bit synchronizes the receiver clock of the UART/ACIA in the host. Timing errors are thus non-cumulative.

Troubleshooting

If you have problems in making the converter work properly, the best way to troubleshoot is through a terminal program on the host. Install jumper JP1. This jumper will force bit 6 of the trnsmitted code high, which means that DC1/DC3 control codes will now be displayed as letters 'Q' and 'S'. Then, with the converter connected between the host and the printer, take the printer offline and send enough characters to fill the printer buffer (effectively generating a BUSY signal). You should then receive a DC3 code (now displayed as letter 'S') back in your terminal program. Take the printer back online. The printer should start printing and you should receive a DC1 code (letter 'Q') as soon as the buffer empties. If the order of the received codes is reversed, invert the BUSY signal by tieing jumper JP2 to ground instead of +Vdd. If you receive garbage characters, check the baud rate, word length, stop bits and parity. The host should be set up to accept baud rate of 2400, 7 data bits, 2 stop bits and no parity (same as 7 data bits, mark parity and 1 stop bit). If nothing is received at all when the printer is taken offline and online, then scope test test point TP1 on the converter. A negative-going pulse should be observed each time the printer goes busy or not-busy. Presence of pulses here indicates the fault to be in the shift register, counter, or RS232 driver circuitry. Absence of pulses here would suggest problems in the "previous state" flip-flop circuitry. Be sure to remove JP1 when you are finished. One final note: The frequency of the oscillator does change with the circuit voltage, so set the frequency at the voltage at which the converter will operate. Alternatively, you can install the optional zener diode D8, provided DSR or DTR line voltage is sufficient. This way, the frequency will not change with different line voltage. A current limiting resistor in place of jumper JP3 is needed if DSR or DTR line is powered by an external power supply and not by an RS232 line driver.

The author's manuscript was printed using WordStar with X-on/X-off protocol, the protocol converter and a lead control serial printer.◀CD▶